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Original Research Article

Lateral pterygoid muscle attachment type is related to the pathogenesis of anterior disc displacement, Disc degeneration and articular surface degeneration- A Magnetic Resonance Imaging assessment

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Abstract

Aim: The aim of this study was to investigate if correlation exists between Lateral pterygoid muscle (LPM) attachment type and Anterior disc displacement (ADD), disc degeneration or articular surface degeneration in the population of central India.
Methods: Patients with complains of pain, clicking, locking in the Temporomandibular Joint (TMJ) region were evaluated. TMJ dysfunctions were classified as normal disc position, ADD with reduction and ADD without reduction. LPM attachment types to the condyle disc complex were classified into three different types. Statistical analysis was conducted using the R version 3.2.0. Statistical correlation analysis was used to investigate the existence of correlation between TMJ dysfunction and LPM attachment types to the disc condyle complex, disc degeneration and articular surface degeneration.
Results: Of 108 TMJ'S in 54 patients (42 males and 66 females, mean age 32.20 years) 25 TMJ'S(23.14%) were evaluated as normal in terms of disc status, 61TMJ'S (56.48%) had an ADD with reduction and 22 (20.37%) had ADD without reduction. Arthritis was seen in 104 TMJ'S (96.30%) suggesting a high prevalence (96.3%) of TMJ osteoarthritis among young patients (mean age 32.2 years). LPM attachment types to the disc condyle complex were Type I (87.03%), Type II (11.11%) and Type III (1.85%). Statistically significant difference was found between the type of LPM attachment and ADD (P value 0.0285). No statistically significant difference was found between LPM attachment type and disc degeneration or articular surface degeneration.
Conclusion: LPM attachment type is related to the pathogenesis of ADD but is not related to disc degeneration and articular surface degeneration.
Keywords: Lateral pterygoid muscle attachment, Anterior disc displacement, osteoarthritis, Temporomandibular joint disorder, magnetic resonance imaging

1. Introduction

Temporomandibular Joint Disorders (TMD) has a high prevalence rate (up to 40-75%) in a general population among adults in United States of having at least one sign of the disorder [1]. TMJ dysfunction is a common problem and affects almost one third of all the adults [2]. According to some studies, TMJ dysfunction affects up to 28% of the population [3]. Internal derangement is considered to be the most frequent cause of TMJ dysfunction. Internal derangement means an alteration in the normal pathways of motion of the TMJ, which is ultimately related to the function of the articular disc [4]. Magnetic Resonance Imaging (MRI) of TMJ has lead to better understanding of TMJ and its disorders. Currently MRI is considered to be the best imaging modality for the evaluation of soft tissues of TMJ'S without exposing the patient to radiation [5]. MRI gives valuable information of the articular disc, joint effusion, lateral pterygoid muscle, bone marrow changes in condyle. It has been stated that LPM plays an important role in the etiology of TMJ disorders [6]. LPM is directly attached to the TMJ and it participates in the function of mastication.

LPM consists of two heads, a superior head (SHLP) and an inferior head (IHLP). IHLP originates from lateral surface of lateral pterygoid plate and inserts onto the anteromedial surface of condyle. SHLP originates from the infratemporal surface of the sphenoid bone and inserts into the anterior and anteromedial surface of capsule and disc. Several theories have been proposed to explain the onset of internal derangement of TMJ [10]. Few studies have found the correlation between the type of lateral pterygoid muscle attachment and the pathogenesis of anterior disc displacement [11,12], while many other studies did not find any such correlation [13]. Also few studies tried to find if the type of LPM attachment is related to disc degeneration and articular surface degeneration [14]. Varied results were found.

The aim of this study was to test the hypothesis that LPM attachment type is related to the pathogenesis of anterior disc displacement, disc degeneration and articular surface degeneration on MRI imaging and to evaluate if these different types of LPM attachments are related to internal derangement of TMJ in a central India population.

2. Materials and Methods

2.1 Study population

This was a cross sectional study carried out in the department of oral medicine and Radiology and department of Radiodiagnosis. All the patients with complains of one of either TMJ clicking, TMJ locking, pain and restricted motion of jaw or jaw deviation who approached the department between August 2014 to November 2015 were included in the study. These patients were evaluated in the department of oral medicine and Radiology.

Patients with rheumatoid arthritis, trauma, condylar hyperplasia, congenital craniofacial syndrome or who had undergone surgical treatment for TMJ disorders were excluded from this study. Patients with posterior disc displacement were excluded.

108 TMJ'S from 54 consecutive patients (42 males, 66 females, mean age-32.20 years) were evaluated in the department of oral medicine and Radiology. Informed consent from the patients was received. The research protocol was approved by the ethical committee of the institution.

2.2 Imaging protocol

Patients underwent TMJ MRI study with a 1.5 Tesla MRI Scanner(General Electronics medical systems Signa HD XT 16 Channel MRI).Bilateral sagittal oblique images were repeated with open and closed mouth positions in T1 Weighted imaging (T1WI), T2Weighted Imaging (T2WI), Proton Density Weighted Imaging(PDWI).

The parameters were as follows: For T2WI: FOV-10X10, Slice thickness-3, TR-2289, TE- 77.5, matrix-256X224, acquisition mode-2D. For T1WI: FOV-10X10, Slice thickness-3, TR-699, TE-19.8ms, matrix-256 X224, acquisition mode- 2D.

2.3 Categorisation of Lateral pterygoid muscle attachment type to the disc condyle complex [14]:

LPM attachment types were categorized into three different types: Type I-Superior head fibres were attached to the disc and the inferior head of LPM was attached to the condyle.

Type II-Superior head having one bundle reaching both disc and condyle, inferior head involves only condyle.

Type III-Superior head to disc, middle part and inferior head to condyle.(figure 1 a,b,c)

2.4 Classification of disc displacement

Based on data obtained from dynamic MRI studies, disc displacements of the TMJ'S were classified into three main groups: normal (N), disc displacement with reduction (DWR) and disc displacement without reduction (DWOR). Assessment of anterior disc displacement was done on sagittal oblique plane in both closed mouth (figure 2 a) and open mouth positions (figure 2 b) and was adapted from Ahmad *et al* [15]. If the posterior band of the biconcave disc was not positioned on top of the mandbular condyle (in the 11 to 12 o'clock position) in a closed mouth position than the disc was considered to be displaced anteriorly.

In our study, other imaging features like articular surface degeneration (osteoarthritis) and disc degeneration were also recorded. The MRI diagnosis of TMJ osteoarthritis was defined as flattening, subchondral sclerosis, and surface erosion, osteophytes of condylar articular surface or sclerosis and flattening of the articular eminence of temporal fossa and was adapted from Ahmad *et al* [15]. (Figure 2 a,b)

Normal disc morphology shows biconcave structure in sagittal images with homogenous signal intensity. The MRI diagnosis of disc degeneration was defined as disc deformities like thickening, irregularity, flattening, folded and perforation.

2.5 Statistical analysis

Statistical analysis was conducted using the R version 3.2.0.

Statistical relationship between lateral pterygoid muscle attachment type to the type of disc displacement, disc degeneration and articular surface degeneration were studied with correlation analysis and assessed if statistically significant correlation exists between them. Correlation was considered to be statistically significant when the probability value is less than 0.05. ($P \leq 0.05$)

3. Results

Of the 108 TMJ's from 54 patients (42 males and 66 females, mean age= 32.20 years), 25 TMJ's (23.15%) were assessed as normal, 61 (56.48%) TMJ's had a DWR and 22 (20.37%) TMJ's had a DWOR. Arthritis was seen in 104 TMJ's (96.30%). High prevalence (96.3%) of temporomandiular joint osteoarthritis was found among young patients (mean age32.2 years). Distribution of the TMJ pathologies are summarised in table 3 to 6.

The insertion of the superior head of Lateral pterygoid muscle to the articular disc was clearly visible in MR images, especially on oblique T2W Sagittal sections.

The prevalence of different type of lateral pterygoid muscle attachment to the condyle disc complex was as follows: Type I(87.03%), Type II (11.11%) and Type III(1.85%)(Table 6).

There was statistically significant correlation found between the type of muscle attachment and the presence or absence of disc displacement (p=0.0285). No statistically significant correlation was found between type of muscle attachment and disc degeneration (p=0.7685) and articular surface degeneration (p=0.648).

Table 3A: Disc displacement

LPM Type	Disc displacement		
	Normal	DWR	DWOR
I	22	57	15
II	3	4	5
III	0	0	2
p value is 0.0285 significant			

LPM-Lateral pterygoid muscle,
Normal (N),
Disc displacement with reduction (DWR) and
Disc displacement without reduction (DWOR)

Table 3B: Disc displacement

Disc displacement	Frequency	Percent %
Normal	25	23.15%
DWR	61	56.48%
DWOR	22	20.37%
Total	108	100

Table 4A: LPM type and disc degeneration

LPM	Disc degeneration	
	Normal	Abnormal
I	11	83
II	2	10
III	0	2
p value is 0.7685		

Table 4B: Disc degeneration

	Frequency	Percent %
Normal disc	13	12.04%
Disc degeneration present	95	87.96%
Total	108	100

Table 5A: LPM attachment type and articular surface degeneration

LPM	Articular surface degeneration	
	Normal articular surface	Articular surface degeneration present (Arthritis)
I	3	91
II	1	11
III	0	2
p value is 0.648		

Table/Fig 5-B: Articular surface degeneration

	Frequency	Percent %
Normal articular surface	4	3.70%
Arthritis	104	96.30%
Total	108	100

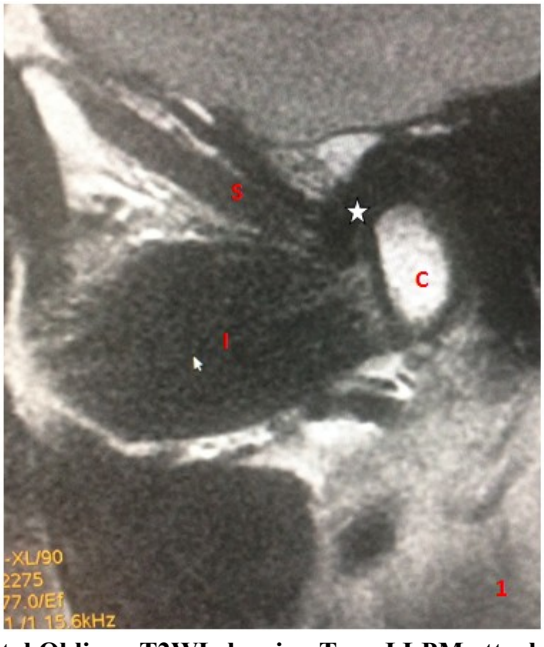
Table 6: LPM attachment type

Type	Frequency	Percent%
Type I	94	87.03%
Type II	12	11.11%
Type III	2	1.85%
Total	108	100

Table 7: Comparison of LPM attachment types of different studies with the present study

	Dergin *et al*[14]	Naidoo *et al*[25]	Pompei Filho *et al*[22]	Present study
Type I	29.6%	65%	-	87.03%
Type II	40.8%	7.5%	-	11.11%
Type III	29.6%	27.5%	20.22%	1.85%

Type I



S-Superior head,
I- Inferior head,
C- Condyle, Star and
D -Disc,
AE-Articular eminence

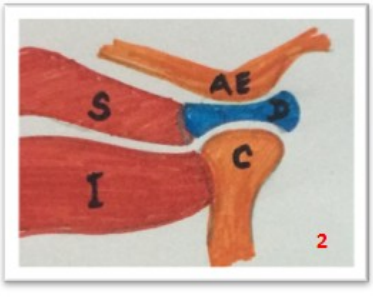
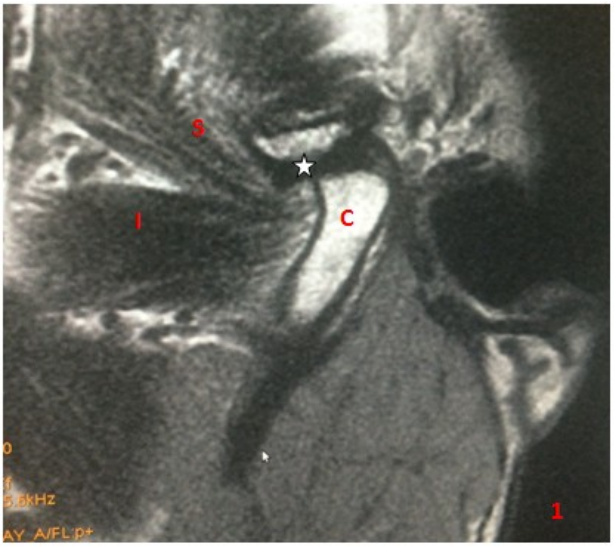


Fig 1a: 1. MRI Sagital Oblique T2WI showing Type I LPM attachment i.e Superior head attached to the disc, Inferior head is attached to Condyle.
2. Graphical representation of Type I.

Type II



S-Superior head,
I- Inferior head,
C- Condyle, Star and
D -Disc,
AE-Articular eminence

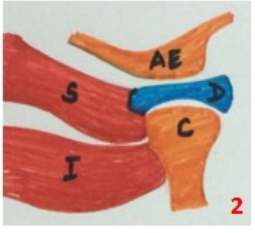
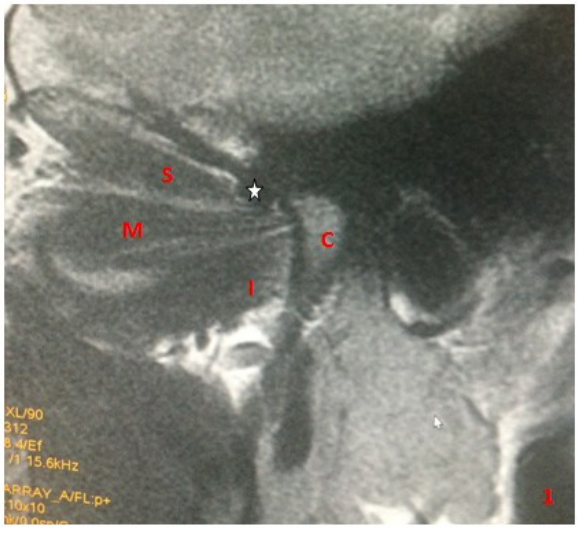


Figure 1b: 1.MRI Sagital Oblique T2WI showing Type II LPM attachment i.e Superior head attached to the Condyle and disc, Inferior head is attached to Condyle.
2. Graphical representation of type II.

Type III



S-Superior head,
I- Inferior head,
M-Middle head
C- Condyle, Star and
D -Disc,
AE-Articular eminence

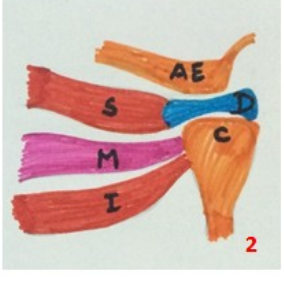


Figure 1c: 1.MRI Sagital Oblique T2WI showing Type III LPM attachment i.e Superior head attached to the disc, Middle part and Inferior head is attached to Condyle.
2. Graphical represenatation of type III.

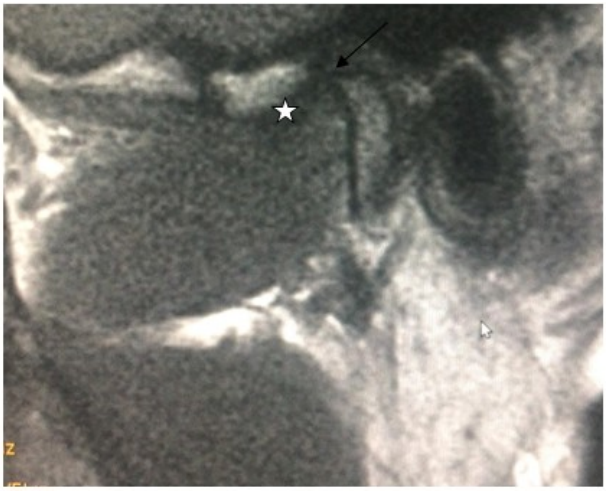


Figure 2a: MRI Sagital Oblique T1WI (closed mouth position) showing anterior disc displacement (star) associated with osteoarthritic changes i.e anterior osteophyte (arrow), cortical erosion and irregular articular surface.

Figure 2b: MRI Sagital Oblique T1WI (open mouth position) showing anterior disc displacement without reduction (star) and anterior osteophyte along the condyle (Black arrow).

4. Discussion

In a study by Murray [16] lateral pterygoid muscle is commonly thought to be responsible for anterior disc displacement. Also autopsy studies suggested that the manual traction of superior head of lateral pterygoid muscle causes forward displacement of the whole disk-condyle complex [17-19].

Since SHLPM is attached to only disc in type I, the disc may displace anteriorly very easily. This leads to reduced function of SHLPM and finally muscle atrophy [7]. Electromyographic (EMG) studies carried out showed SHLPM to have maximum activity and shows horizontal isometric jaw forces in a range of direction [20].

In a study by Carpentier *et al* [21], it was seen that the main insertion of superior head were not into the disc but it was into the condyle. With this anatomic consideration, the anterior disc displacement merely due to spastic activity of muscle was less likely. It was stated that hypotonicity of the upper head may be responsible for an anterior and medial disc displacement.

In the present study, type I LPM attachment type was found in 87.03%. Of these 87.03%, 76.59% of type I were showing anterior disc displacement .In type II LPM attachment type 75% of type II showed anterior disc displacement (Out of total 12 type II attachments types, 9 were showing anterior disc displacement). In type III attachment type, 100% showed anterior disc displacement (two TMJ's has type III attachment and both these cases showed ADD). In type I and type III attachment types, SHLPM is attached only to disc and in type II, superior head is attached to the disc and condyle as well. Type III may be considered an anatomical variant [22].

In the present study, statistically significant relation was found between type of lateral pterygoid muscle attachment and presence or absence of disk displacement (P value -0.0285).

However no significant relation was found between LPM insertion type and disc displacement in the studies by Taskaya yilmaz *et al*, Dergin G *et al* and Imanimoghoddam *et al* [7,14,23].

Type I was the commonest type of insertion found in the studies by Naidoo LC *et al*, Kilic C *et al* and Imanimoghoddam *et al* [22-25]. However Imanimoghoddam *et al* [23] study has evaluated the insertion pattern of lateral pterygoid muscle with magnetic resonance imaging and stated that the most common variation (type I)was seen to be the superior head with two bundles, one bundle being attached to the disc and another bundle being attached to the condyle. Similarly Kilic *et al* [24] and Naidoo *et al* [25] studied the insertion patterns in the human cadavers and post-mortem specimens respectively and categorized the insertion patterns and stated that type I is the attachment type in which upper head is inserted into the disc condyle complex and condyle. Kilic C *et al* [24] labelled this as type I and found it in 36.7% cases and Naidoo LC *et al* [25] found this type of attachment pattern in 65% of specimens. So as far as these studies [23-25] were concerned type I SHLPM attachment pattern corresponds to type II attachment pattern of the present study.

According to Kilic C *et al* [24], type II attachment pattern was in which the upper head is inserted into the disc and the lower head is inserted into the condyle and this was

found in 26.6 % of human cadavers. This type II of Kilic C *et al* [24] corresponds to type I of the present study.

In the present study, Type I was categorized as, Superior head fibres attached to the disc and the inferior head of LPM was attached to the condyle. Similar type of categorization was observed in Taskaya –Yilmaz *et al* and Dergin G *et al* [7,14]. Our Type I categorization corresponds to type II of Kilic C *et al* [24].

In this study, commonest type of LPM insertion found is Type I which is consistent with Taskaya Yilmaz *et al* [7]. However in a study by Dergin G *et al* [14] commonest type of LPM insertion pattern was found to be Type II (40.8%). In a study by Kilic C *et al* [24], type I LPM attachment pattern which corresponds to type II attachment pattern of the present study, was found to be 36.7%.

It was observed that the LPM insertion pattern where superior head inserting into the Disc and condyle and inferior head inserting into the condyle was found to be more common in Imanimoghoddam M *et al* [23], Kilic C *et al* [24], Naidoo LC *et al* [25] studies. These studies were carried on cadavers and post-mortem specimens. Whereas LPM insertion pattern where superior fibres inserting into disc and inferior fibres inserting into condyle was found to be more common in Taskaya –Yilmez *et al* [7] study and present study. This assessment was done on MRI. This discrepancy in the observations needs to be taken into consideration and further studies with emphasis particularly on this aspect, needs to be carried out.

The prevalence of third head of LPM was found to be 20.22% by Pompei Filho *et al* [22], 29.6% by Dergin G *et al* [14] and 27.5% by Naidoo LC *et al* [25]. In our study it was found to be very less i.e 1.85%.(Table 7)

In this study, statistically significant difference was not found between type of LPM insertion and disc degeneration (*p* value-0.76).This was consistent with Dergin G *et al* study [14] .

TMJ osteoarthritis is generally more prevalent in older age group than in younger age group. However high prevalence of temporomandibular joint osteoarthritis among the young patients was found in a study by Wiberg and Wanman *et al* [26] and DP de Melo *et al* [27].

Present study also showed high prevalence (96.3%) of temporomandiular joint osteoarthritis among young patients (mean age 32.2 years). Psychosocial factors such as emotional problems, anxiety, depression, increased level of stress may be more responsible than anatomic factors in this young population group with TMD. However present study has not included these psychosocial factors. Future study needs to be carried out to study this probable association.

But no significant correlation between type of LPM insertion and articular surface degeneration was found in the present study. This was consistent with Dergin G *et al* study [14].

5. Limitations of the study

This study was conducted on 54 patients i.e. total 108 TMJ's. Though statistically sample size was adequate but increase in the number of cases would make the results of the study more generalisable. This study was carried out in a single institute with two radiologists in the same location. Also both the radiologists did not discuss the individual study among them and hence reduced discussions between them. This may have lead to lower reliability than if the radiologists were done the evaluation together.

6. Conclusion

While concluding, this study found a statistically significant correlation between the three types of muscle attachment to the disc condyle complex and the presence or absence of disc displacement. Lack of correlation was found between type of LPM insertion and disk degeneration or articular surface degeneration.

From this study, it can be said that lateral pterygoid muscle attachment type is related to the pathogenesis of anterior disc displacement and hence to the internal derangement of TMJ disorders. The knowledge of type of LPM attachment may help in determining the tendency for TMJ disorders and clinicians may offer preventive treatment for patients who are found to be at risk.

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